

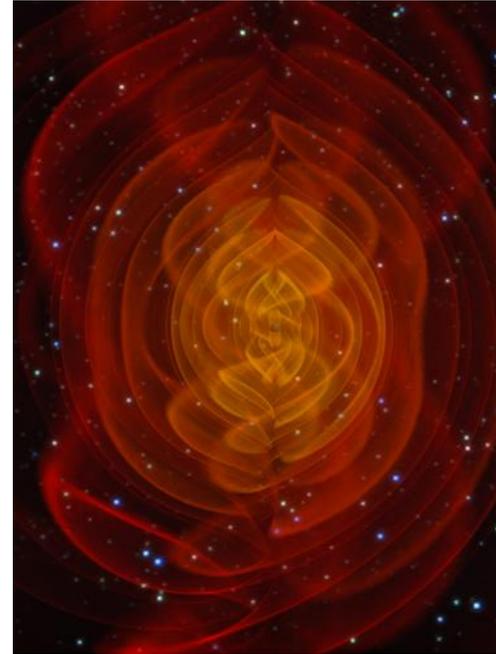
# LISA Study Office

Ira Thorpe, NASA LISA Study Scientist

Gravitational Wave Science Interest Group Meeting

Gaylord National Harbor

January 8<sup>th</sup>, 2018



# What is a Study Office?

- A ‘proto-project office’
  - Conducts early design studies
  - Coordinates technology development
  - Refines science case

NASA Life-Cycle Phases	FORMULATION		IMPLEMENTATION				
	<i>Pre-Systems</i>	<i>Acquisition</i>	Approval for Implementation		<i>Systems Acquisition</i>	<i>Operations</i>	<i>Decom- missioning</i>
Project Life-Cycle Phases	<b>Pre-Phase A:</b> Concept Studies	<b>Phase A:</b> Concept and Technology Development	<b>Phase B:</b> Preliminary Design and Technology Completion	<b>Phase C:</b> Final Design and Fabrication	<b>Phase D:</b> System Assembly, Integration and Test, Launch	<b>Phase E:</b> Operations and Sustainments	<b>Phase F:</b> Closeout

# Who is the LISA Study Office?

Astrophysics at  
NASA/HQ  
NASA PCOS

ESA Study  
Office

NASA LISA  
Study Team

Leadership  
Horowitz (manager)  
Thorpe (scientist)  
Hornschemeier (dep. Scientist)  
Rioux (systems engineer)

Core Team  
Technology  
Data Analysis  
Astrophysics  
Engineering

General  
Science  
Community

LISA  
Consortium

# What we do: Mission Development

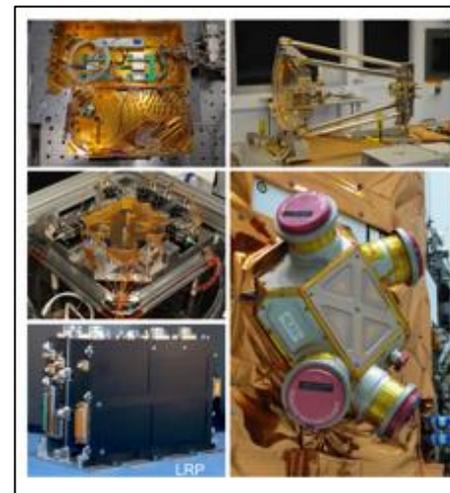
- **“ground-level” interface with ESA**
  - Regular telecons & frequent visits
  - In parallel with HQ-HQ discussions
- **Support ESA & LISA Consortium**
  - Spacecraft Phase 0 study
  - Payload Phase 0 study
- **Targeted technical analyses**
  - Phased array antennas for LISA communications
  - NASA Deep Space Network utilization
  - Mission analysis (orbits)



The Concurrent Design Facility (CDF) room at ESTEC during the LISA Phase 0 mission study.

# What we do: Technology Development

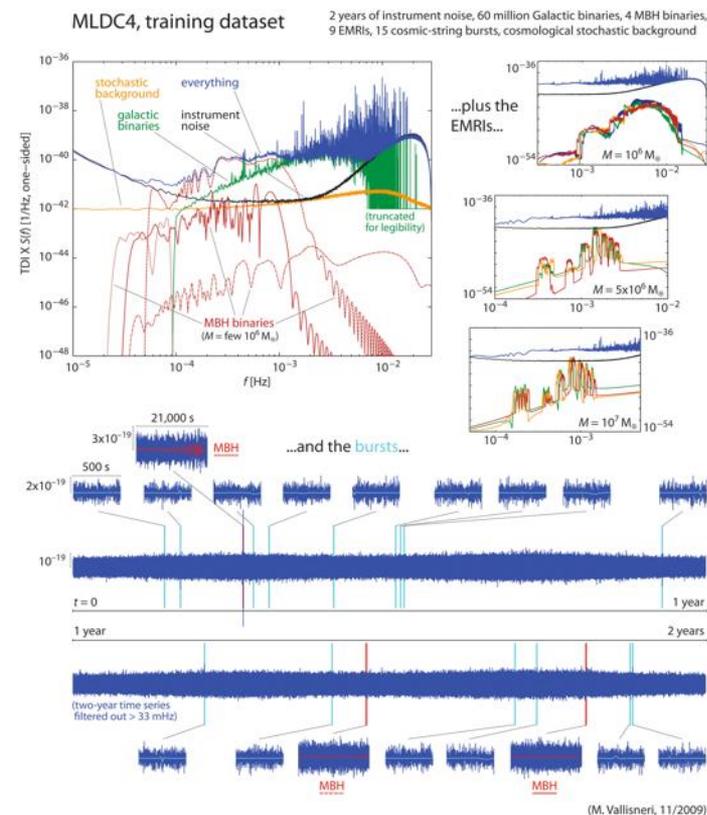
- **Manage development for potential US contributions**
  - Track development milestones
  - Harmonize with ESA's requirements and schedule
- **Current activities**
  - Charge Management (UF)
  - Colloidal Micropropulsion (JPL)
  - Laser system (GSFC)
  - Phase Measurement System (JPL)
  - Telescope (GSFC)



The Concurrent Design Facility (CDF) room at ESTEC during the LISA Phase 0 mission study.

# What we do: Science and Analysis

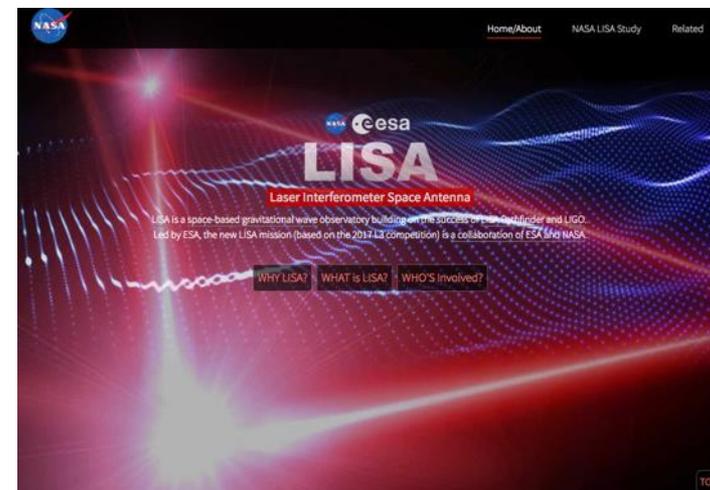
- Organize and support US participation in Core Data Science Activities
  - Instrument simulator
  - Data challenges
  - Development of proto-pipelines
  - Study of potential US contributions to ground segment / data centers / etc.
  - Close coordination with ESA & Consortium



Sample data set from the last “Mock LISA Data Challenge” of the prior LISA project.

# What we do: Community Interface

- **Facilitate Study Team Activities**
  - Travel for US members on ESA's Science Study Team
  - Travel/Logistics for NASA Study Team
- **Outreach**
  - New website
  - Support for decadal preparation
  - Support / facilitate activities of NASA Study Team / Consortium



The revamped [lisa.nasa.gov](http://lisa.nasa.gov) which launched this summer

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# Technology Development

# History & Context

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- **2001-2011**
  - Range of technologies developed under auspices of LISA project
  - Project helped harmonize requirements, interfaces, etc.
  - Examples: Microthrusters, Phasemeters, Stabilized Lasers, Metrology technologies, etc.
- **2011-2017**
  - PI-led activities
    - Lasers, telescopes, stable structures, frequency references, atom interferometry...
    - supported by competitive research funds
    - Requirements drawn from community
  - other missions
    - Micropropulsion: ST7-DRS / LISA Pathfinder
    - Phasemeter: GRACE-FO LRI
- **2017-**
  - Study office “consolidates” technology development

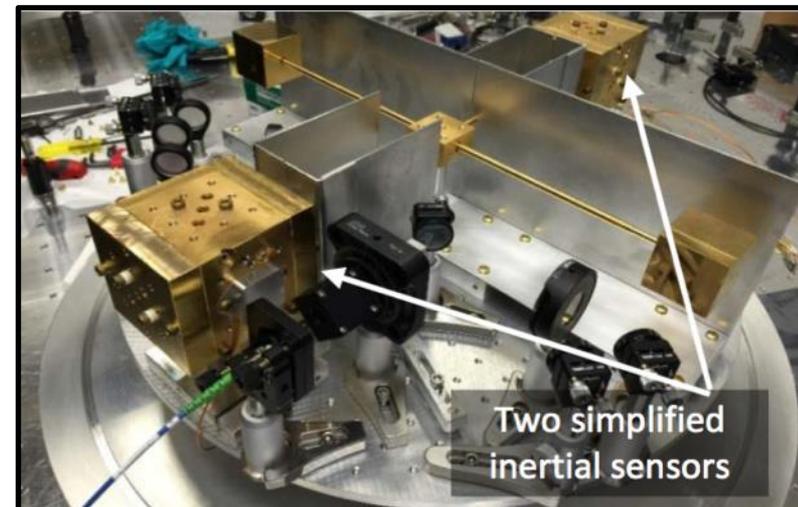
# Philosophy of US Technology Development

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- **Develop full “menu” of possible US contributions**
  - room for decision-makers to satisfy constraints and desires
  - Will need to downselect eventually
- **Study Office coordinates interaction with European partners**
  - Development and refinement of requirements and interfaces
  - Information from and feedback to mission design and development
- **Guided by input from L3 Study Team (June 2016)**
  - impact & insight
  - US heritage
  - Simplicity of interfaces & integration

# Charge Management

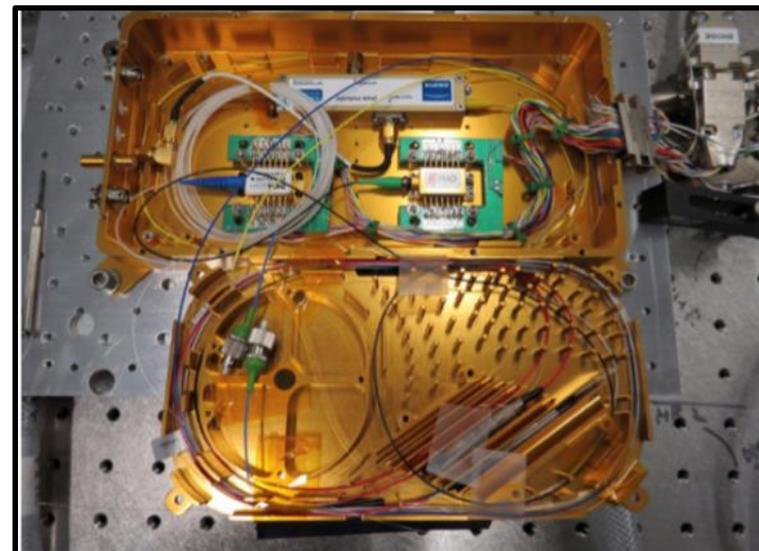
- **Lead:** John Conklin, University of Florida
- **Summary:** Develop non-contact charge management system based on UV LEDs.
- **Partnership Plan:** US contribution to consortium
- **Development Activities:** Develop prototype, test on UF torsion pendulum facility and other facilities.



UF Torsion pendulum facility with simplified “GRS” for use in demonstrating charging at a system level. (Conklin).

# Laser System

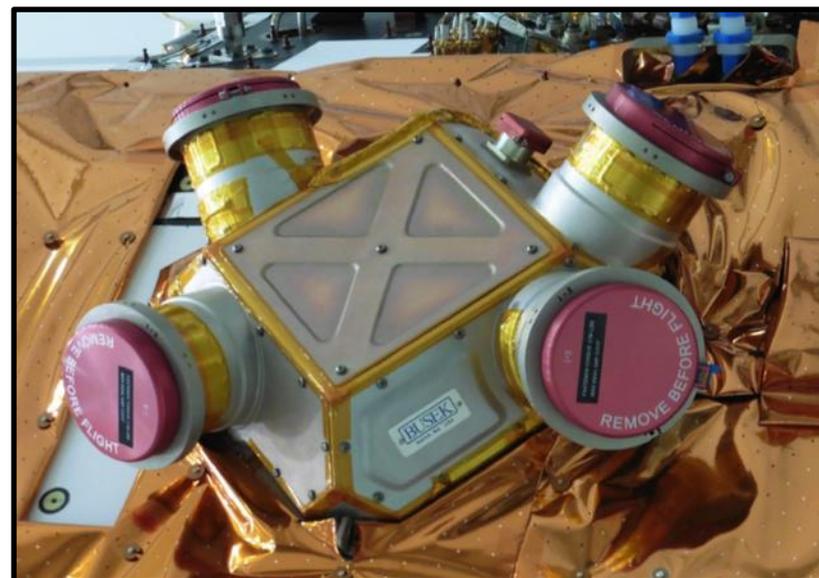
- **Lead:** Tony Yu & Jordan Camp (GSFC)
- **Summary:** Develop stable laser system
- **Partnership Plan:** direct US contribution to ESA/consortium
- **Development Activities:** Develop prototype based on MOPA architecture. Trade on NPRO vs. ECL MO and fiber amplifiers. Partner with US industry as appropriate.



Prototype ECL-based laser system at GSFC  
(Numata/Camp/Krainak)

# Micropropulsion

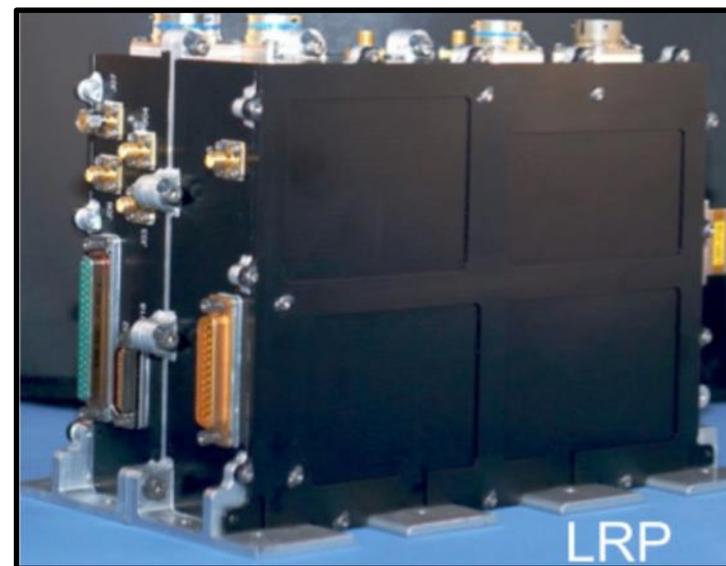
- **Lead:** John Zeimer, JPL
- **Summary:** Develop Colloidal Micronewton Thruster System building on ST7/LPF heritage and lessons learned
- **Partnership Plan:** US contribution to ESA
- **Development Activities:** Modify ST7 design to address lifetime and reliability and conduct lifetime tests.



Colloidal Micronewton thruster cluster on LPF.  
(JPL/J. Zeimer)

# Phase Measurement Systems

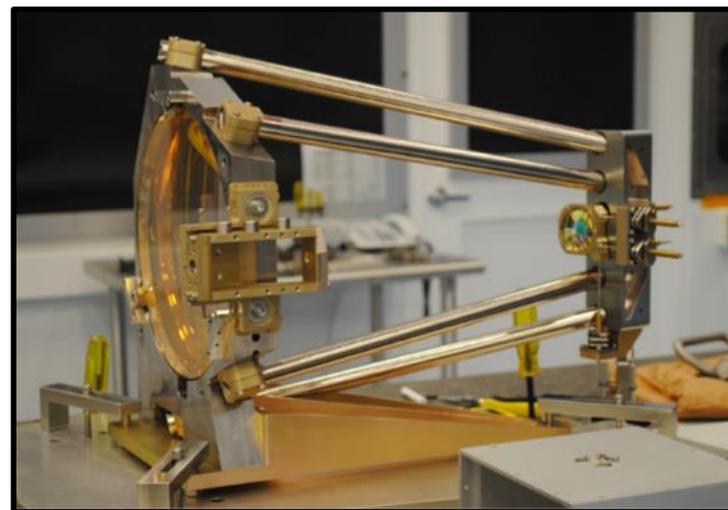
- **Lead:** Bill Klipstein, JPL
- **Summary:** Develop Phase Measurement System building on GRACE-FO/LRI and LISA heritage
- **Partnership Plan:** US contribution to consortium
- **Development Activities:** Re-introduce LISA functionality to GRACE-FO design. Conduct tests and develop prototypes.



Laser Ranging Processor (FM) for GRACE-FO LRI  
(JPL/Klipstein)

# Telescope Systems

- **Lead:** Jeff Livas (GSFC)
- **Summary:** Develop and test LISA telescope system.
- **Partnership Plan:** US contribution to ESA/ consortium, possibly to include some I&T of related items.
- **Development Activities:** Design, purchase, and test telescope prototypes for dimensional stability and scattered light. Partner with US industry as appropriate.



(top) Telescope functional prototype for scattered light tests. (bottom) Draft mechanical design (yellow)

